Kurata Laboratory (Special Issue on the Commemoration of the Fortieth Anniversary)

KURATA LABORATORY (September 1962~)

Head: Dr. Michio Kurata

This laboratory was estabished in September 1962, after the appointment of Dr. Kurata as a professor of this institute. Since then, physico-chemical studies of macromolecular substances, both theoretical and experimental, have been carried out with the intention of obtaining a clear understanding of the interrelation between physical properties and chemical structures of macromolecules. These studies are divided into three categories, of each a brief description will be given below.

The first category includes theoretical studies of chain conformations and hydrodynamic properties of macromolecules in dilute solution. A new theory of the so-called excluded volume effect has been developed, which provides a method of wide application for estimating the unperturbed chain dimension from the light-scattering and viscosity data. The hydrodynamic properties of non-linear macromolecules have recently evoked much practical interest, for these provide a primary source of informations on the branched chain structure of high-pressure polyethylene or synthetic rubbers and also on the twisted ring structure of DNA molecules. Thus, the problems have been investigated theoretically.

The second group of our studies consists of experimental analysis of the polymer chain conformation by means of light scattering, osmotic pressure, viscosity and sedimentation measurements. Several polymers with significant molecular structures have been systematically investigated: these are polystyrene with an extremely high degree of isotacticity, a series of polyethers including poly (tetrahydrofuran) and poly (propylene oxide), and a series of poly (α-substituted methyl acrylates). As a result, it becomes clear, for example, that the highly isotactic species of polystyrene has a helical structure of fairly long sequence even in good solvent. The research program along this line is now going to be extended in two directions; one is to polyelectrolytes and the other to anionically prepared macromolecules, e.g. block copolymers and various types of branched polymers. Under the auspice of the grant-in-aid of the Ministry of Education, a ultracentrifuge of Spinco E type was installed in this laboratory in the last year. This makes it possible not only to obtain a complete set of informations on the hydrodynamic properties of macromolecules, but also to work out all experiments under a guarantee of known distribution of polymer molecular weight.

In the third place, a series of viscoelastic measurements of polymer solutions has been carried out in collaboration with the research group in Prof. Tamura's laboratory of this University. The main purpose of this project is to reveal the nature of hydrodynamic and elastic interactions between chain elements of macromolecules. Still another experimental study in this category is also in progress on the glass transition phenomena by using a series of anionically polymerized α-methyl styrene.

Senior research members working in this four years are:

Dr. Ryuzo Koyama (September 1962–March 1964)
Dr. Hiroyasu Utiyama (September 1962–)
Dr. Masaaki Fukatsu (April 1964–)*
Mr. Mitsuo Abe (May 1966–)
Dr. Hisashi Odani (November 1966–)

Other members consist of three technical assistants, two doctoral thesis students, five master thesis students and three undergraduate students in this academic year (April '66–March '67)

Finally, Prof. Walter H. Stockmayer of Dartmouth College, U.S.A. has been a guest of this laboratory for two months (October-November) in this year, to whom we are grateful for many fruitful discussions.

Publications

I. Polymer Chain Statistics and Hydrodynamics

1. M. Kurata and W.H. Stockmayer: Intrinsic Viscosities and Unperturbed Dimensions of Long Chain Molecules, *Fortschr. Hochpolym.-Forsch.*, **3**, 196 (1963).
2. M. Kurata, M. Fukatsu, H. Sotobayashi and H. Yamakawa: Second Virial Coefficient of Linear Polymer Molucules, *J. Chem. Phys.*, **41**, 139 (1964).
3. M. Kurata and M. Fukatsu: Unperturbed Dimension and Translational Friction Constant of Branched Polymers, *J. Chem. Phys.*, **41**, 2934 (1964).
4. H. Utiyama and M. Kurata: Light Scattering from Dilute Solutions of Flexible Chain Polymers Consisting of Optically Anisotropic Segments, *Bull. Inst. Chem. Res., Kyoto Univ.*, **42**, 128 (1964).
5. R. Koyama: Shear Rate Dependence of Flow Birefringence of Polymer Solutions, *J. Phys. Soc. Japan*, **19**, 1709 (1964).
6. M. Fukatsu: Hydordynamic Properties of Dilute Solutions of Ring Polymers, *Bull. Inst. Chem. Res., Kyoto Univ.*, **43**, 156 (1965).
7. M. Kurata: Hydrodynamic Properties of Dilute Solutions of Ring Polymers. II. Twisted Ring Polymers, *Bull. Inst. Chem. Res., Kyoto Univ.*, **44**, 150 (1966).
8. M. Fukatsu and M. Kurata: Hydrodyanmic Properties of Flexible-Ring Macromolecules, *J. Chem. Phys.*, **44**, 4539 (1966).
9. M. Kurata: Ellipsoid Model for Polyelectrolytes, *J. Polymer Sci.* C. in press.
10. M. Kurata: Some Recent Aspects in Polymer Solution Theory, *Pure and Applied Chemistry*, **12**, 587 (1966).

II. Experimental Studies of Polymer Solution Properties

11. M. Kurata, H. Utiyama and K. Kamada: Unperturbed Dimensions of Poly (tetrahydrofuran),, *Makromol. Chem.*, **88**, 281 (1965).
12. H. Utiyama: Physicochemical Studies on Isotactic Polystyrene, *J. Phys. Chem.*, **69**, 4138 (1965).
13. M. Iwama, H. Utiyama and M. Kurata: Dilute Solution Properties of Poly (α-substituted methyl acrylates). I. Poly (methyl ethacrylate) and Poly (methyl n-butacrylate), *J. Macromol. Chem.*, **1**, 701 (1966).
14. M. Kurata, M. Iwama, and K. Kamada; Viscosity-Molecular Weight Relationships and

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* Note added in proof:—Dr. Fukatsu died of apoplexy on December 4, 1966. He was 31 years old. A slight bruise which he had received during experiment in the beginning of September was believed the remote cause of this tragedy. We deeply regret the death of this young and able scientist.

Unperturbed Dimensions of Linear Chain Molecules, in Polymer Handbook, (ed. by J. Brandrup and E.H. Immergut, Interscience Pub., New York, 1966), IV–1–72.

III. Viscoelastic Properties

15. K. Osaki, M. Tamura, T. Kotaka and M. Kurata; Normal Stresses and Dynamic Moduli in Polymer Solutions, *J. Phys. Chem.*, **69**, 3642 (1965).
16. K. Osaki, M. Tamura, M. Kurata and T. Kotaka; Complex Modulus of Concentrated Polymer Solutions in Steady Shear, *J. Phys. Chem.*, **69**, 4183 (1965).
17. M. Tamura, M. Kurata, K. Osaki and K. Tanaka; Normal Stress Effect in Dilute Polymer Solutions. I. Polystyrene in Dioctyl Phthalate, *J. Phys. Chem.*, **70**, 516 (1966).
18. K. Osaki, K. Tanaka, M. Kurata and M. Tamura; Normal Stress effect in Dilute Polymer Solutions. II. Polystyrene in Chlorinated Diphenyl, *J. Phys. Chem.*, **70**, 2271 (1966).

IV. Miscellaneous

19. R. Koyama; Study on Molucular Structure of Polymethyl isopropenyl ketone by X-ray Diffraction Method, *Bull. Inst. Chem. Res., Kyoto Univ.*, **41**, 207 (1963).